

Claims

1. A fluid pressure disturbance damping arrangement (40; 140; 240) for a fluid driven actuation device (10; 100; 200) including an actuator (20), a fluid pump (30), a fluid supply line (32) for delivering fluid from the pump to the actuator at relatively high pressure and a fluid return line (36) for delivering fluid from the actuator to the pump at relatively low pressure,
said damping arrangement comprising an elongate flexible damping hose (42; 142) in fluid communication with at least one of the supply and return lines, the hose having a longitudinal axis and about said axis a peripheral wall (46₁; 46₂) defining, in a cross-sectional plane perpendicular to the axis, a non-circular area of magnitude related to pressure exerted on the peripheral wall by contained fluid, said peripheral wall being responsive to impulsive or vibrational pressure disturbances in the contained fluid to deform and restore locally changing the shape of the cross section area defined thereby to dissipate energy associated with the pressure disturbance.
2. A damping arrangement according to claim 1 wherein the peripheral wall (46₁; 46₂) of said damping hose is arranged to define different cross-sectional areas at different longitudinal positions.
3. A damping arrangement according to claim 1 or claim 2 wherein the peripheral wall is arranged to change shape in response to contained fluid pressure disturbances without storing the disturbance energy solely as elastic stretching the peripheral wall.
4. A damping arrangement according to claim 3 wherein the damping hose has a wall construction including interwoven strands arranged to displace relative to each other during deformation of cross sectional shape of the hose and absorb deformation energy as frictional loss between the strands.
5. A damping arrangement according to any one of the preceding claims, wherein, for a predetermined length of hose, the peripheral length of the hose wall is

substantially fixed.

6. A damping arrangement according to any one of the preceding claims, wherein the hose has two opposing first wall parts (46_{1F}, 46_{2F}) normally closer together than two orthogonally disposed opposing second wall parts (46_{1S}; 46_{2S}).

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7. A damping arrangement according to claim 6, wherein in the absence of fluid pressure the peripheral wall (46₁) tends to a shape defining an elliptical cross section.

- 10 8. A damping arrangement according to claim 6, wherein in the absence of fluid pressure said first wall parts (46_{2F}) are arranged to contact each other.

9. A damping arrangement according to any one of the preceding claims, wherein the damping hose (142, 242) is arranged to be located in fluid communication with the return line of said fluid actuation device adjacent the actuator.
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10. A damping arrangement according to any one of the preceding claims, wherein the damping hose (42; 242) is arranged to be located in, and to pass fluid of, the return line of said fluid actuation device adjacent the actuator.

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11. A damping arrangement according to any one of the preceding claims, wherein the damping hose is of fixed length.

12. A damping arrangement according to claim 11 suitable for use with a power assisted steering rack (20) of a vehicle, wherein the damping hose is arranged to be carried along its length by the steering rack.
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13. A fluid driven actuation device (10; 110; 210) including an actuator (20), a fluid pump (30), a fluid supply line (32) for delivering fluid from the pump to the actuator at relatively high pressure, a fluid return line (36) for delivering fluid from the actuator to the pump at relatively low pressure, and a pressure disturbance damping arrangement (40; 140; 240) comprising, in fluid communication with at least one of the supply and return lines, an elongated
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flexible damping hose (42; 142; 242) having a longitudinal axis and about said axis a peripheral wall (46₁; 46₂) defining in a cross-sectional plane perpendicular to the axis a non-circular area of magnitude related to pressure exerted on the peripheral wall by contained fluid, said peripheral wall being operable in response to impulsive or vibrational pressure disturbances in the contained fluid to deform and restore locally changing the shape of the cross section area defined thereby to dissipate energy associated with the pressure disturbance.

14. A fluid driven actuation device according to claim 13, wherein the damping hose (42; 242) is located in the return line (32) adjacent the actuator, providing a passage for return of the fluid from the actuator to the pump.

15. A fluid driven actuation device according to claim 13 or claim 14, wherein the damping hose of the pressure disturbance damping means is of fixed length.

16. A fluid driven actuation device according to claim 15, wherein the damping hose is supported along its length by the actuator.

17. A fluid driven actuation device according to any one of claims 13 to 16, wherein the peripheral wall (46₁; 46₂) of said damping hose is arranged to change shape in response to contained fluid pressure disturbances without storing the disturbance energy solely as elastic stretching the peripheral wall.

18. A fluid driven actuation device according to claim 17 wherein the damping hose has a wall construction including interwoven strands arranged to displace relative to each other during deformation of cross sectional shape of the hose and absorb deformation energy as frictional loss between the strands.

19. A fluid driven actuation device according to any one of claims 13 to 18 wherein, for a predetermined length of hose, the peripheral length of the hose wall is substantially fixed.

20. A fluid driven actuation device according to any one of claims 13 to 19 wherein

the hose has two opposing first wall parts (46_{1F}; 46_{2F}) normally closer together than two orthogonally disposed opposing second wall parts (46_{1S}; 46_{2S}).

21. A fluid driven actuation device according to claim 20, wherein in the absence of fluid pressure the peripheral wall (46₁) tends to a shape defining an elliptical cross section.
22. A fluid driven actuation device according to any one of claims 13 to 21 wherein in the absence of fluid pressure said first wall parts (46_{2F}) are arranged to contact each other.
23. A fluid driven actuation device according to claim 13, wherein the actuator includes a power assisted steering mechanism for a road vehicle.
24. A power steering arrangement for a road vehicle wherein the actuator comprises a steering rack or box having a casing mounted on the vehicle, said power steering arrangement comprising a fluid driven actuation device according to claim 13.
25. A power steering arrangement according to claim 24 wherein the drive fluid is a hydraulic liquid and the damping hose is in the return line.
26. A power steering arrangement according to claim 24 wherein the damping hose has its peripheral wall in contact with the casing of the steering rack or box for substantially the whole length of the hose.
27. A method of damping disturbances in fluid pressure within a fluid driven actuation device (10; 110; 210) including an actuator (20), a fluid pump (30), a fluid supply line (32) for delivering fluid from the pump to the actuator at relatively high pressure, a fluid return line (36) for delivering fluid from the actuator to the pump at relatively low pressure, the method comprising coupling to at least one of the supply and return lines, an elongated flexible damping hose (42; 142; 242) having a longitudinal axis and about said axis a peripheral wall (46₁; 46₂) defining in a cross-sectional plane perpendicular to the axis a non-circular

area of magnitude related to pressure exerted on the peripheral wall by contained fluid, and causing said peripheral wall to deform and restore locally in response to impulsive or vibrational pressure disturbances in the contained fluid changing the shape of the cross section area defined thereby dissipating energy associated with the pressure disturbance.

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28. A method according to claim 27 comprising inserting the damping hose (42; 142; 242) in the actuation device return line adjacent the actuator (20).

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29. A method according to claim 27 or claim 28 comprising supporting the damping hose with its peripheral wall in contact with the casing of the actuator (20) for substantially the whole length of the hose.